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**OFF THE SHELF AND INTO THE TRASH BIN:
SGT YORK, NDI INTEGRATION AND ACQUISITION REFORM**

BY

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**Off the Shelf and Into the Trash Bin:
SGT YORK, NDI Integration and Acquisition Reform**

by

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ABSTRACT

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The defense budget, a significant component of the discretionary portion of federal expenditures, is severely constrained and under attack. Defense acquisition reforms have been aggressively initiated to offset the effects of reduced resources. An attractive acquisition method in vogue with decision makers and now actively underwritten by acquisition reform initiatives is the use of nondevelopmental items (NDI). The NDI concept is focused on adapting existing items, including components and technologies, to meet military requirements. In the early 1980's the Army initiated development of the \$4.14 billion Division Air Defense (DIVAD) or SGT YORK gun, in today's terms, as an NDI Integration effort and then subsequently canceled the program at great expense and embarrassment. The paper, looking at DIVAD, identifies and highlights some issues associated with NDI acquisitions and decision implications for future programs using NDI Integration acquisition strategies.

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Off the Shelf and Into the Trash Bin: SGT YORK, NDI Integration and Acquisition Reform

Introduction

The nation's military forces are significantly smaller and less widely deployed since the Cold War has ended. Concurrently, military budgets are now drastically smaller. The services, caught in the dilemma of "pay me now or pay me later," have had to postpone investments in modernization. There is little flexibility to acquire needed future capabilities or replace assets as they wear out. Near term requirements dictate resource priorities as there is little choice but to fund the day-to-day operation and maintenance of forces in being and current missions such as those ongoing in Bosnia. After more than five years of defense draw down, the investment in future advanced capabilities has been supplanted by immediate requirements. In effect, we are "eating the seed corn." The services cannot safely ignore the need to re-capitalize and modernize the force much longer.

Consequently, multiple activities are underway to squeeze the most "bang" from the few acquisition "bucks" available. One acquisition reform concept, enthusiastically cited in multiple articles and speeches, is the use of "off-the-shelf" technologies. The idea is to adapt existing technologies or even complete systems already developed in other military programs or derived from advanced commercial developments. These Non-Developmental Items (NDI) - almost

universally described as "mature" - may be usable as is or, hopefully, only require minimal additional development. The amalgamation of multiple NDI elements into complete, advanced weapon systems is a process known as NDI Integration. Clearly, or so the theory goes, this strategy is cheaper, quicker and possesses significantly reduced technological risk than a full scale, "from scratch" research and development effort.

In the view of the author, many senior decision makers have little practical knowledge and experience about what it takes to convert "good ideas" into practical hardware and software. They assume that it is simple to combine already developed (NDI) technologies to create complex weapon system with advanced features. Although an attractive theory, nothing is ever as easy as it seems. The Division Air-Defense Gun System (DIVAD) or SGT YORK¹, subsequently canceled after significant cost and effort, is one example where the results failed to meet expectations. This paper, looking at DIVAD, will highlight some issues associated with NDI acquisitions and decision implications for future programs using NDI Integration acquisition strategies. This discussion is specifically designed to assist understanding by those who do not habitually operate in the defense acquisition environment.

Fiscal Context

The larger national fiscal environment is a major factor driving the current

climate of defense fiscal austerity. There is now a national focus on a domestic agenda, particularly health care and welfare, and the need to balance the federal budget. Non-discretionary entitlement programs are encumbering available resources. There is significant pressure for diversion of a greater measure of proportionally smaller discretionary resources to offset the ever growing non-discretionary requirements of the federal budget.² The defense budget, a significant component of the discretionary portion of the federal budget pie, is severely constrained and under attack. Defense modernization investment accounts (Research and Development, Acquisition) are being reduced in response to the larger federal budget context and those remaining defense resources are prioritized toward maintaining force structure and the readiness of operational forces. "Because the discretionary portion of the budget is so tightly constrained, the prospects for defense will remain grim for some time to come."³

The following charts, recently presented by a senior Army acquisition official, show a snapshot of projected resources and the modernization dilemma. The first chart (Figure 1) shows that as the amount of Research, Development and Acquisition (RDA) dollars available has increased in absolute terms by eight percent, actual purchasing power has declined by ten percent. The second chart (Figure 2) shows that modernization will be limited. Development activities will be severely curtailed and needed programs have been terminated to fund only the highest priorities.

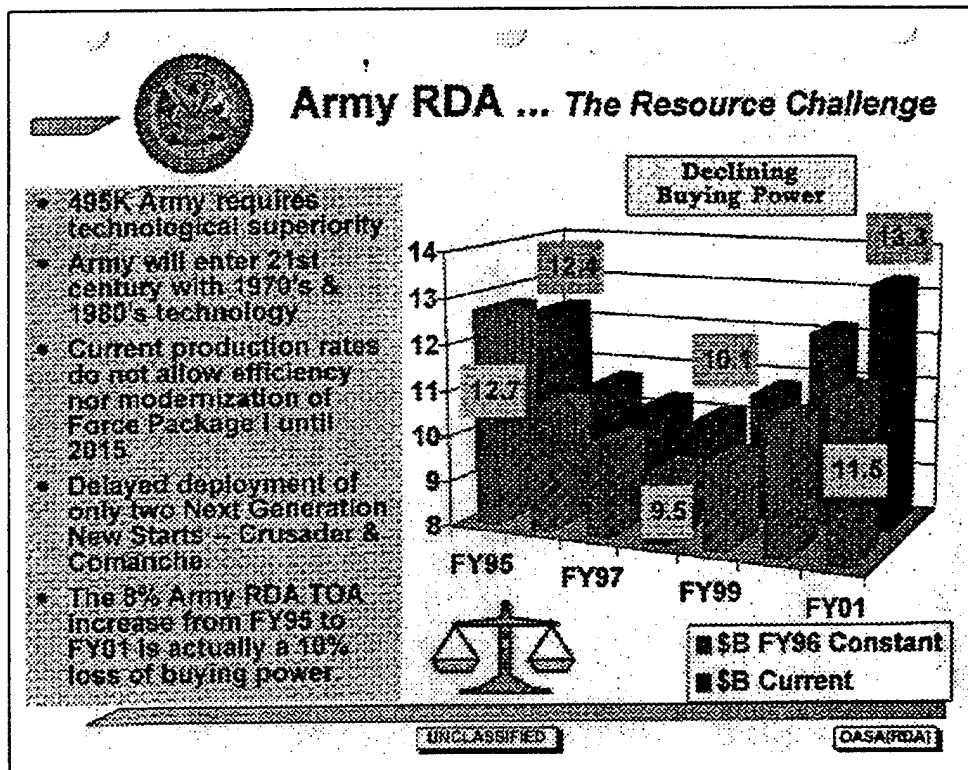


Figure 1: Army Research, Development & Acquisition (RDA) Resource Projections⁴

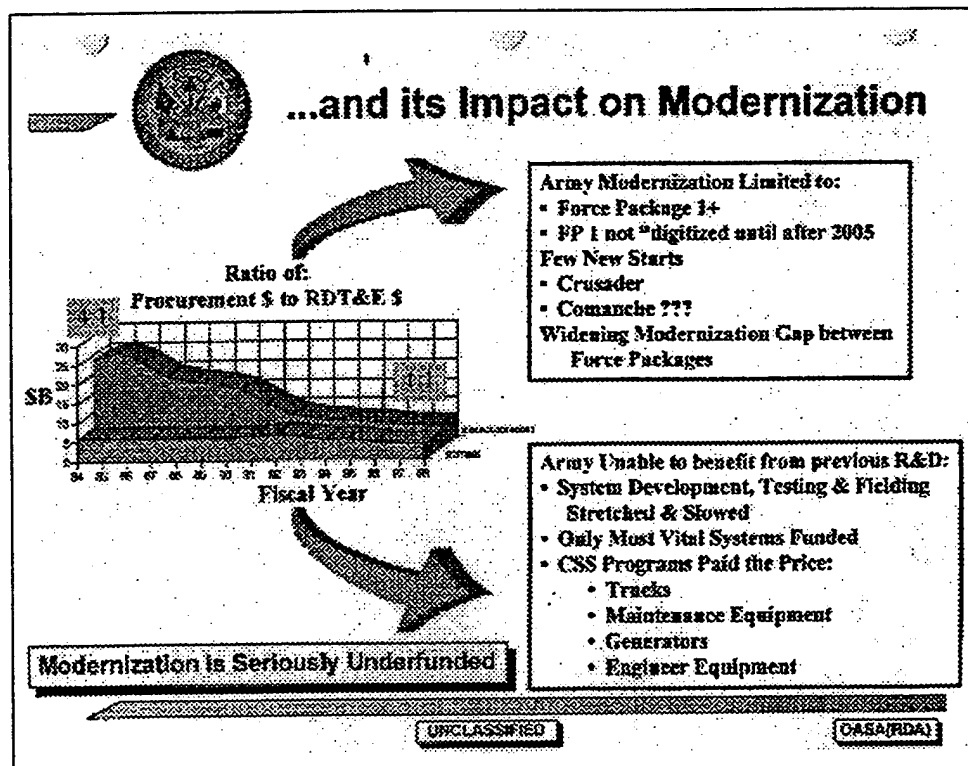


Figure 2: Army Modernization Resource Impacts⁵

Defense Acquisition Reform

Despite the great debate over how and when to balance the federal budget and other national priorities (entitlement programs), undercapitalization of the armed forces will likely prevail for the foreseeable future. Consequently, actions are underway within the defense establishment to get the most value from available modernization dollars to maintain a modicum of modernization momentum. Defense acquisition reforms have been aggressively initiated to promote efficiency and partially offset the effects of reduced budgets.

The need for acquisition reform, voiced by many, has been succinctly stated by C. G. King, President of the Boeing Defense and Space Group, as. . .

. . . a national security issue. There is an urgent need for force modernization, but resources are constrained. Therefore, non-value-added requirements and bureaucratic layers must be eliminated . . .⁶

While the total defense budget has been reduced by 40 percent over the last ten years, procurement resources have been reduced by over 65 percent.⁷ There is general agreement on the need for dramatic procurement changes to squeeze the most value from the available dollars and make it more responsive to warfighting needs.

What is different about defense acquisition? The difference is, in a word, complexity. Multiple interactive processes and "players" make the acquisition system incredibly complex. There is a thicket of unique laws, regulations and policies. One review identified over 900 procurement laws.⁸ Long cycle times, governed by a Life Cycle Model that typically fields weapons in 12 to 15 years, characterize acquisition.⁹ This "lock step" model, constrained by unique laws, regulations, accounting and auditing practices, and oversight requirements, has limited inherent agility. It is clearly not the right model for the times.

The acquisition world assesses and measures progress within the context of three interactive elements: cost, schedule, and technical performance. A change to any of these variables inevitably affects the others. Effects can range from dramatic, short term consequences (i.e., "kill a program") to subtleties that may take years to fully emerge. Balancing risk and negotiating compromise within the dimensions of cost, schedule and performance defines the "battlespace" of the materiel developer. This triad provides a useful vantage points from which to examine acquisition reform.

Acquisition cost growth above initial program estimates, has become a normal expectation. The search for "better" performance coupled with schedule changes (usually lengthened) are generally offset by the application of additional dollars. Costs grow to compensate for schedule slippage or to improve system

technical performance or both. Thus, services nurture programs until an acceptable weapon is finally fielded or the program is severely crippled or killed off as too painful in light of other priorities. The most recent and very dramatic example is the Navy's now canceled, A-12 stealth bomber program. Two noted defense commentators, George Wilson and Peter Carlson of the Washington Post, describe the A-12 Avenger program as "a procurement fiasco that has already cost American taxpayers more than \$3 billion and is quite likely to cost them \$2 billion more."¹⁰ And not one plane ever left the ground!

Until now, acquisition decision behavior has generally treated cost as "dependent variable."¹¹ The "deep pockets" approach of throwing more money at a problem is no longer affordable nor acceptable to the people, the Congress, or internal institutional resource competitors. Acquisition must learn to "live within our means." The paradigm must be altered to make the cost component independent of and the controlling factor that determines how much technical performance we can afford and when we can afford to have it.¹² More so in the future than in the past, sobering realism will be applied during program definition (Is it a valid and vital requirement?) and program execution (Is the function value-added to the effort?) for efficiency and to save money.¹³

In the area of technical performance, it is well known that technology changes and changes very rapidly. Technology is widely proliferating and readily

available, worldwide, to anyone who can afford it. Potential threats, recognized and unrecognized, can and will acquire comparable or more advanced weapons than our own. Without some level of modernization investment, this nation can't maintain its expected measure of overwhelming technological superiority.

The uncomfortable fact for the future is that we cannot afford to meet all requirements with new systems or even upgrade all of the old systems on hand. Weapons that we can afford may not be all that we might want or all that is technically feasible. The challenge will be to correctly assess which technologies are worthy of investment. Once a materiel solution for a mission need is shown, weapon system technical performance requirements and specific features must be chosen and priorities set wisely. We must discipline the process to suppress any appetite to "make it better" after reaching consensus, approval and validation of the basic system requirements (performance baseline). Change to a performance baseline ("requirements creep") adds cost, lengthens the acquisition cycle time and must be resisted.

NDI

One procurement idea viewed as more efficient is to increase the use of existing, "off-the-shelf" items, otherwise known as Non-Developmental Items (NDI).

Nondevelopmental items are any previously developed

item of supply, to include software, used exclusively for governmental purposes by a Federal Agency, a State or local government, or a foreign government with which the United States has a mutual defense cooperation agreement.¹⁴

More broadly, commercial items are also considered "nondevelopmental" as well.¹⁵ The NDI concept focuses on the wholesale adoption and adaptation of existing hardware and software to meet a specific military requirement. A major acquisition reform effort, increased emphasis on the NDI idea, seeks to leverage existing technologies rather than to invest in a complete bottoms-up research and development programs for new weapons.

An NDI procurement, in its purest form, is when the government goes to industry and buys items that are identical in every respect with those sold commercially. There is no requirement that the item have any unique military features or meet any of the myriad military specifications (MILSPEC) or military standards (MILSTAN). Obvious examples include some items of clothing, such as underwear; commercial grade vehicles for garrison support activities, such as sedans and pickup trucks; common hand tools; office automation equipment or any of the thousands of other commercial products used throughout the services.

NDI is a clear-cut choice when such items will be used for virtually the same activities and in similar environments for which it was originally designed

and marketed for in the commercial sector. Draft documentation, reflecting the most current thinking and emerging policy about acquisition practices, requires efforts be undertaken to adjust requirements and conduct market surveys to search out existing suitable technologies in preference to new developments. "In defining requirements you must give first preference to the use of commercial and second preference to the use of other types of NDI. This is a provision of the Federal Acquisition Streamlining Act."¹⁶

NDI procurement opportunities span a broad spectrum. Commercial items may be bought "off-the-shelf" as is or ruggedized or militarized to better meet the desired or required military requirements. NDI components may be included in an otherwise classic total development effort but in such a way that does not closely resemble the original application. Finally, existing technologies, components or subsystems can be adapted, combined and integrated to result in an end item. This last subset of the NDI concept is tagged "NDI Integration."¹⁷

A Simple Example

For example, it is not likely that the Navy can buy a destroyer down at the local marina. However, it is possible that the Navy may have a requirement for a small harbor patrol craft like a Boston Whaler. Although not originally designed for the purpose, the Navy may find that a coat of gray paint and the addition of a machine gun mount and military communications gear may result in just the item

they need. And it is cheaper and easier to accomplish. Most NDI procurements involve some modification to whatever item is being considered for purchase for use in a context other than for which it was originally designed. This is a natural consequence of needs to improve the basic equipment's ability to withstand long term use in severe environments and the incorporation of uniquely military capabilities such as weapons and communications.

NDI is attractive to decision makers. NDI is perceived to shorten acquisition cycle time, reduce cost and leverage previous technology investment. The remainder of this paper surveys one NDI integration program to underscore issues ("practice") that can be in dissonance with expectations ("theory").

Division Air Defense Gun (DIVAD) (a.k.a. Sergeant York)

During the early 1980's the Army identified a requirement to improve the short range air defense (SHORAD) capabilities organic to ground combat maneuver forces. Subsequently, a major Army acquisition program was initiated to develop the Division Air-Defense Gun System (DIVAD). The DIVAD program aimed to "produce a mobile, radar-controlled, all weather gun system that would replace Vulcan and provide close-range, low altitude air defense for armored and mechanized units."¹⁸ An original requirement of 618 weapon systems provides a convenient scale to judge the scope of the DIVAD program.¹⁹ The total cost of putting the complete Sergeant York force in the field, including research and

development, was estimated at \$4.14 billion.²⁰ This was not a small program!

Then Secretary of Defense, Caspar Weinberger ultimately canceled the DIVAD program in August 1985 with "a sunk cost of \$1.8 billion and seven years of development time with no weapon to show for it."²¹ SGT YORK is often cited as a major embarrassment to the government and industry acquisition communities, Air Defense branch and the Departments of the Army and Defense.

Anyone who is remotely familiar with the history of the SGT YORK program can probably recite a lengthy list of reasons, some factual and many with roots only in folklore, why the program failed. A short list of popularly ascribed reasons for failure would probably include confusion over the basic requirement, lack of consensus by the Air Defense community, supposed chicanery by the prime contractor, purported rigging of government tests, inaccurate cost estimates, optimistic engineering projections, changing political fortunes, internal Army bickering and, last but not least, inaccurate and irresponsible press reporting.²²

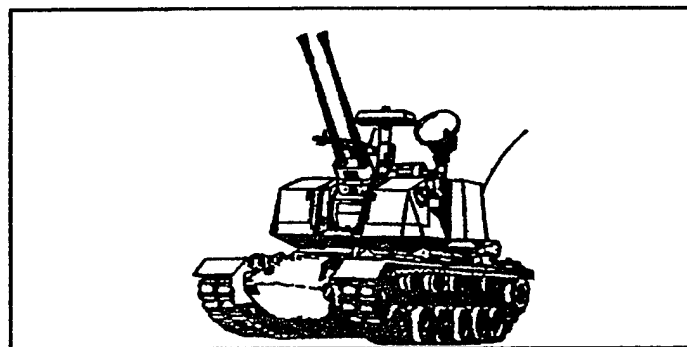


Figure 3: Division Air Defense Gun (DIVAD)
a.k.a. SGT YORK

The SGT YORK cancellation decision was, in reality, driven by a complex mosaic of circumstances and interactions beyond the scope of this paper. Suffice it to say that there is still little agreement among participants and observers about the viability of the DIVAD concept and the conduct of the program. In the words of one wise sage, "Where you stand depends on where you sit." However, it is useful to look at the NDI aspects of the program but to do so without wading through the swamp of rhetoric and emotionalism that surround SGT YORK.²³

Key to the DIVAD program was the decision to accelerate the development process. The number of steps normally followed in development programs were truncated to reduce development time and cost.²⁴

. . . the normal heel-to-toe sequencing in a typical acquisition strategy was to move the program from Concept Exploration (CE) into . . . the Demonstration/Validation phase . . . and jump the program directly into Full Scale Development. This phase is normally three or four years further down the pike. The key to being able to do this would be the use of "off-the-shelf" components, that is, proven components that are already being manufactured for some other purpose.²⁵

The DIVAD acquisition strategy would use "proven components from other applications."²⁶ "The prototypes themselves were supposed to integrate these

mature components in such a way as to facilitate mass production."²⁷ The following table summarizes the significant "mature" components and their sources:

<u>Component</u>	<u>Source</u>	<u>Pedigree</u>
Chassis	U.S. Government Furnished Equipment (GFE): Anniston Army Depot refurbishment & modification	M48A5 Tank
L/70 Cannon (2 ea.) & Ammunition	U.S licensed production of Bofors (Sweden) design	Various ground combat and naval applications in use by 50 countries
Radar	Westinghouse Electric Corp. (U.S.)	F16 Aircraft
Laser Range Finder	Hughes Aircraft (U.S.)	Modified M60A3 tank components
Attitude Reference Unit	Litton Industries (U.S.)	Modified aviation components
Plasma Display	SAIC (U.S.)	U.S. tank applications
Identification Friend or Foe (IFF)	Hazeltine Company (U.S.)	General purpose air-to-ground interrogator developed for Foreign Military Sales
Gas Turbine Engine (Turret auxiliary power unit)	Garrett (U.S.)	Adaption of aviation ground support (flight line) equipment

Figure 4: DIVAD "Off-the-Shelf" Components ²⁸

While there were other "off-the-shelf" piece parts and assemblies used in the system, those listed were the most significant based on size, complexity, cost and integration challenge. All of the components and technologies selected for modification and integration had a proven track record over a number of years

and, by any standard, were "mature" in the sense that they basically did the job for which they were originally designed. An implicit assumption of the off-the-shelf approach was that the performance characteristics and maintenance requirements of each of the selected components were thought to be well understood and transferable to DIVAD.

At program initiation "expectations were high."²⁹ The DIVAD Project Office anticipated multiple advantages associated with the use of mature components including:

- Significant reduction in delivery lead time for prototypes
- Economy of scale through use of existing or slightly modified designs produced on active, proven production lines.
- Reliability is well known.
- Maintenance concept and logistics base are already established.³⁰

Furthermore, mature components were anticipated to:

- Minimize prototype and production lead times
- Save significant development cost
- Increase certainty of meeting performance and reliability (requirements)³¹

After program termination the DIVAD Project Office made a wide-ranging assessment of the conduct of the program in several documents that constitute

what we now call an After Action Review (AAR). Specific NDI-related judgements about the use of mature components include:

- The "integration effort (was) more extensive than anticipated."³²

Other program references suggest that the "magnitude of (the) system integration effort was underestimated."³³ This is a significant point as any increase in engineering effort can only adversely impact program cost and schedule.

- "Could not have achieved development schedule otherwise."³⁴ The program originally planned to field the DIVAD within six years from program initiation.³⁵ The actual schedule required nine years.³⁶ This must still be judged as a significant improvement over the twelve-plus years that is the average for major systems.

- "Did not compromise performance significantly."³⁷

- "Extensive knowledge of 'old' vs. 'new' environments required to scope changes adequately."³⁸ This remark talks to the need to understand the design criteria and application environment for which an item was originally designed so that appropriate adjustments could be made for its NDI application. Imperfect understanding of the selected NDI elements' design parameters led directly to engineering changes to adapt to the new environments.³⁹ Again, this can only cause unplanned budget and schedule pressures.

- "Less than expected commonality of line replaceable units based on differences in application and maintenance concept."⁴⁰

- Permitted the design and fabrication of two prototypes in only

twenty-nine months. This was done at a development cost of \$267M while systems of comparable complexity required investments of between \$500M and \$1B.⁴¹

- The greater than anticipated integration difficulties associated with mature components required additional unplanned testing.⁴² The direct consequences would have likely translated into increased program cost, added test program complexity and a lengthening of the test schedule. In fact, the program ultimately incorporated an unplanned Check Test that contributed to adding another year to the program.⁴³

Comments by one member of the SGT YORK program management team provide a telling comment about the amalgamation of "off-the-shelf" items.

(Program risk was) initially thought to be low. After all, the candidate components were "mature" (whatever that means). We found out the hard way that we had to do engineering and test-fix-test work to mature the components in a new environment. In addition, we underestimated the job of making all the pieces work together. Today we call that systems engineering.⁴⁴

Comprehensive understanding of the full significance behind the assessment of the NDI aspect of the program requires delving into the technical

details of SGT YORK engineering design, integration activities, test incident reports (TIR) and evaluation results. There were multiple and difficult design issues and tradeoffs made by the government and contractor during the life of the SGT YORK program. Highlights concerning two of the major NDI elements, the mobility and armaments systems, are illustrative of the SGT YORK experience.

Chassis

Integration difficulties resulted from modifications made to the chassis. The M48A5 tank chassis, the major component furnished by the government to the contractor, had been in use for years in the U.S. and foreign tank fleets. In addition, the chassis technology was very similar to that of the newer M60-series tank, sharing many common components including the air-cooled 12 cylinder diesel engine. In fact, the M48A5 version was an upgrade to the basic M48-series to make it as similar to the M60-series as possible, including the replacement of the old gasoline powered engines with the newer engine.⁴⁵ There was a considerable body of engineering, logistics support, maintenance and operational knowledge and experience about this chassis. The use of the M48A5 chassis was low risk. Or was it?

The SGT YORK application required a series of modifications to the basic chassis, the most visible being changes to the hull configuration. Changes were made to the size, shape and interior volume of the engine compartment. More

room was required to integrate a DIVAD-unique component, "...an additional 72 horsepower gas-turbine engine to generate electrical and hydraulic power for the turret and automotive subsystem..."⁴⁶ The effect of changing the engine compartment configuration and the addition of other components caused changes in the volume of cooling air flow around the engine. Coupled with the fact that the chassis, designed to provide mobility for 53 tons was now required to move 63 tons, had to work harder.⁴⁷ All of this added up to an engine overheating problem requiring more engineering effort to correct.⁴⁸ This is only a simple example of unintended consequences of using a proven component differently than originally intended. Implied impacts include the cascading effects of additional required time for design, fabrication and test of a fix as well as associated costs.

40MM Cannons and Ammunition

DIVAD incorporated twin L/70 automatic cannons designed and distributed worldwide by Bofors of Sweden.⁴⁹ The U.S. Government acquired a license and production rights for the gun.⁵⁰ Data rights acquisition secured an assured domestic source of a critical component and precluded foreign purchases under unfavorable exchange rates. The technical data package (drawings and specifications) was complete. To reduce the complexity of the technical translation, the original metric dimensions were retained rather than convert the design to the English system.⁵¹ However, it was still necessary to convert the

documents to conform to American standard engineering practices. During tests and subsequent examination of American produced parts during investigations of gun performance (rate of fire) "...a feature was found to have been translated from a male (tab) to a female (slot)."⁵²

Similarly, changes were made to the 40mm ammunition design. U.S. materials and processes were substituted for those specified by the Swedish to ease production in an American setting. Efforts were also undertaken to enhance the lethality performance of the gun and ammunition system which caused other impacts.

Besides the manufacturing processes found in all technology transfers, the "Americanization" process also included an increase in cartridge and fuze performance requirements to achieve higher levels of system effectiveness. Performance upgrades, driven by technical requirement changes, affected the propellant design, proximity fuze radome, weapon capabilities and proximity fuze electronic counter counter measures (ECCM). Substitution of CONUS equivalent components and processes led to performance problems with the primer and proximity fuze safe and arm devices.⁵³

Similar to use of the M48 tank chassis, the technology transfer of the Technical Data Package for production of such mature designs as the L/70 gun

and ammunition would seem to have been relatively straight forward. The reality turned out to be more complex than anticipated. Issues included unanticipated difficulties in just understanding a proven technology (the gun) well enough to use it as is, not to mention complexities introduced by efforts to change or improve an item (the ammunition).

One view of SGT YORK effort was that . . .

. . . decision makers failed to realize that mature components are not mature when operated in a different environment than that for which they were developed. They seriously underestimated the amount of development required to make components work in a new environment and underestimated the amount of work required to integrate the components into a working system.⁵⁴

Conclusions

What about SGT YORK and NDI integration? Although the terms NDI and NDI integration did not exist at the time, DIVAD sought to accelerate the acquisition process by using existing technologies and components. The DIVAD program shares many characteristics with the current NDI integration concept. It is a reasonable baseline with which to draw conclusions about NDI acquisition in the present constrained budgetary and acquisition reform context.

For DIVAD, two central questions remain, one programmatic in nature and one of an operational character. Did the amalgamation of off-the-shelf parts result in a whole that was much less than the sum of those parts? "It met 87 percent of its specifications and the onus to fix the rest was on the contractor."⁵⁵ Was the DIVAD flawed when compared against a target threat that exceeded the specified engineering objective? "A fuzzy, virtually nonexistent stand-off helicopter threat when the program was conceived, grew eight years later to be a very real, very stark threat."⁵⁶ Actually, the SGT YORK was designed, built and evaluated for significantly less cost and in less time than a comparable system built from scratch precisely because of its NDI-like character. In the end, it just turned out to be a weapon that countered the wrong air defense threat.

There are several broader implications for future programs contemplating an NDI integration acquisition strategy.

- Successful NDI integration must either properly use components and technologies in the form in which they are found, for purposes that closely approximate that for which they were originally designed or investments must be made to adjust the form to meet the requirements at hand. NDI components must be used as is, consistent with their capabilities or modified to meet higher performance requirements. Although performance of an NDI system can be greater than the sum of its parts, those parts, unmodified, cannot perform outside of their original design parameters.

- Extending the capabilities of an item by modification and upgrade may assume many characteristics of a new development and be less "NDI" as a direct result of the complexity combined with any underestimation of the technical challenge.

- Hard-nosed, up front evaluations must be made of the state of maturity of selected "off-the-shelf" technologies, remaining development tasks and modifications or enhancements for the application at hand and interface requirements.

- System technical performance results may be disappointing, if based solely on based on initial piece part evaluation of each "off-the-shelf" (so-called) mature components.

- As in all development programs, unfavorable schedule and cost pressures will result from unanticipated technical difficulties. The probable driver of technical difficulties will be in the development of the interfaces (mechanical, electrical/electronic and software) among NDI components and with newly developed items in the total system.

- NDI integration can't shortcut the engineering process, particularly the effort needed to develop the interface connections. ("It takes what it takes.")

- NDI interface development may be more difficult than similar activities during a traditional complete development program. NDI integration must link components that may be of different technological eras and not possessing a common "system" genealogy. New developments link components that are

conceived of and matured in parallel as part of a larger "system." Design compromises can be more easily made as the system matures during traditional integration compared to NDI integration.

- There are hidden costs to NDI integration.

- Modification and upgrades to update components to the current state of the art will accrue additional design, fabrication and testing efforts.

- Use of technologically dated components will "build in" and accelerate system obsolescence. Industry support of older items may fade away as industry passes on to more profitable, current technology. Look at the computer the chip.

- One tendency will be to seek out components and technologies that push the state-of-the-art. Such technologies may not be ready for integration and production and may well entail hidden development requirements. Once an immature technology is selected, significant effort and investment may unexpectedly be required to make the item meet the specified performance.

The Boston Whaler example and other commercially based equipment, such as a truck, represent NDI integration at the low end of the complexity scale. Those efforts have tended to be historically less difficult to execute. SGT YORK included a significantly more complex set of technologies and encountered more difficulties than originally anticipated. In the past, NDI integration of highly complex systems, coupled with underestimation of technical difficulty, has not necessarily led to

successful outcomes. Contemporary experience suggest that we have expanded our ability to manage complex integrations with greater sophistication, achieving acceptable system effectiveness and program efficiency. A prominent example is the Armored Gun System (AGS). The AGS program significantly updated an available design, fabricated and successfully tested six prototypes and was granted production authority in little over three years. Taken on its own merits, AGS must be judged a highly successful NDI integration program, reaching fruition in approximately a quarter of the time estimated to complete a bottoms-up development⁵⁷. AGS is proof that NDI integration strategies for complex systems is viable and that program may well be a model for the future.

Intelligently conceived NDI programs, that accept prudent risk and maintain realistic expectations, can shorten acquisition cycle times and leverage previous technology investments of the government and private sectors. Fundamentally, NDI-based acquisition strategies can save large amounts of money and time. However, they will not necessarily be easy. The assumed program risk is directly linked to the state of technical maturity and the level of sophistication that the systems integration process must accommodate. Finally, the laws of physics cannot be abrogated. Decision makers should not expect that all cost, schedule and technical problems will be magically avoided by using NDI acquisition strategies.

END NOTES

1. Note that the terms "DIVAD" and "SERGEANT YORK" or "SGT YORK" refer to the same weapon system. Interchangeable use of these terms is reflected in all related documentation. These terms will be used interchangeably throughout this paper.
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15. DOD Handbook 5000.37H, 7.

16. Ibid.

17. Ibid., 11.

18. Eric C. Ludvigsen, "Army Weaponry," Army (October 1980): 270.

19. Eric C. Ludvigsen, "Army Weaponry," Army (October 1982): 359.

20. Ibid.

21. O. B. Korohey, It Seemed Like a Great Idea At The Time: The Story Of The Sergeant York Air Defense Gun (Alexandria, VA: U.S. Army Materiel Command, 1993), v.

22. Ibid, 187-191.

23. See It Seemed Like a Great Idea At The time: The Story Of The Sergeant York Air Defense Gun to get the most unbiased account of the program. Colonel O. B. Korohey has captured the essence of the program difficulties as well as dispassionately laid out the many differing points of view. His simplifying format and lucid explanations provide clarity for the uninitiated as well as the acquisition professional. This book will sensitize the reader to the significant biases contained in all other documentation, particularly press reports of the time.

The following summarizes COL Korohey's conclusions about the DIVAD program and the subsequent cancellation decision:

- The DIVAD; in the context of the acquisition strategy, the state of technology and time available; largely met the requirements dictated in the Operational Requirements Document (ORD). The one exception was shortfalls in the area of Reliability, Availability and Maintainability (RAM). RAM characteristics would have likely been improved with medium to low risk if the program had been permitted to proceed.

- The ORD was not updated nor the DIVAD program adjusted to reflect growth of the targeted air threat over time. DIVAD was designed to perform against a threat of less capability than could be expected on the battlefield. It was canceled as not being militarily useful in the context of the real threat.

During research for this paper, the present author came to question the objectivity and research value of contemporary press reports. They appear to be little more than hear say, sensationalism and, at worst, deliberate disinformation.

24. Sergeant York Program Office, Sergeant York Lessons Learned. (Rock Island, IL: U.S. Army Armament, Munitions and Chemical Command, 1985), 1-03.

25. Koropecy, 47.

26. Ibid. 52.

27. Ibid.

28. Ronald T. Pretty, ed. Jane's Weapon Systems 1983-84 (London: Janes, 1984), 120-121.

Christianson, Charley, Engineer, Ft. Monmouth, NJ, telephone interview by author 8 February 1996. (Mr. Christianson, a former member of PM DIVAD staff, provided his recollections about the laser range finder, attitude reference unit, plasma display, IFF and turbine. All aviation based components were significantly modified to adapt them to the ground environment).

29. Stuart J. Schornstein (schornstein@cc-mail.pica.army.mil), "Re: SGT YORK," electronic mail message to LTC George E. Mauser (mauserg@carlisle-emh2.army.mil), 6 February 1996.

30. Sergeant York Lessons Learned, 1-03.

31. Sergeant York Project Office, The Sergeant York Experience (Rock Island, IL: U.S. Army Armament Munitions and Chemical command, 1985), Tab B, Slide 1.

32. Ibid. Tab A, Slide 3.

33. Ibid. Tab B, Slide 3.

34. Ibid. Tab A, Slide 3.

35. Ibid. Tab A, Slide 1.

36. Ibid. Tab A, Slide 2.

37. Ibid. Tab A, Slide 3.

38. Ibid.

39. Ibid. Tab b. Slide 1.

40. Ibid.

41. Ibid. Tab B, Slide 2.

42. Ibid. Tab G, Slide 2.

43. Ibid.

44. Schornstein.

45. Korohey. 49.

46. Korohey. 73

47. Korohey. 73.

48. This illustration is based upon a vivid personal recollection of the author while assigned as a Test Director of close combat systems at the U.S. Army Combat Test Activity at Aberdeen Proving Grounds, MD during 1984-1986. While not directly involved in DIVAD testing, there was ample opportunity to witness and discuss day-to-day test events with those working on the DIVAD. This anecdote is based on a conversation with the government test director, the test crew and mechanics conducting repairs to correct an overheating condition on one of the fire units. This incident occurred in the Spring of 1985 on the Main Front firing range at APG. Attempts to document further details about the cooling problem, any corrective action taken and impact to overall performance and reliability were unsuccessful. Several references imply that there were further issues surrounding system automotive performance.

Christianson, Charley, Engineer, Ft. Monmouth, NJ, telephone interview by author 8 February 1996. (Mr. Christianson, a former member of PM DIVAD staff, confirmed a DIVAD engine overheating problem related to air flow. The problem was eventually corrected by redesign of the engine cowling.)

49. Jane's Weapon Systems, 120.

50. Sergeant York Lessons Learned, 3-01.

51. Ibid.

52. Ibid. 3-02.

53. Ibid. 3-03.

54. Schornstein.

55. Korohey. 190.

56. Korohey. 191.

57. AGS prototypes met or exceeded overall system cost, schedule and technical performance requirements. However, the Army has indicated the need to terminate this once high priority program in light of higher priorities. The decision to not initiate AGS rate production, in the view of this author, reflects the further erosion of the Army's ability to sustain a modernization program in light of insufficient budget and expanding mission requirements. As of this writing (March 1996)

the official AGS cancellation announcement is pending the outcome of scheduled Congressional budget hearings.

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